RESEARCH PROJECT TITLE: Integrated Management System for Sustained Seed Yield of Kentucky Bluegrass Without Burning.

INVESTIGATORS: Donn Thill and Glen Murray, Univ. of Idaho, and Bill Johnston, Wash. State Univ.

INTERIM REPORT

PROJECT OBJECTIVES:

1. To determine variety and location influence on Roundup suppression of bluegrass, seed yield of three no-till crops, and subsequent bluegrass seed yield for two years.
2. To relate bluegrass seed yield response to Roundup rate and timing, timing of nitrogen application, proportion of productive tiller categories, and fall floral induction.
3. To disseminate information to growers via field representatives, extension educators, field tours, and practical publications and to scientific audiences via publications and presentations.

KEY WORDS: Roundup (glyphosate), chemical suppression, intercrop

STATEMENT OF PROBLEM: Non-thermal bluegrass seed production systems will reduce the consecutive number of bluegrass seed crops from ten or more to about two. More frequent bluegrass establishment, increased potential for soil erosion, and increased annual weeds further decrease economic opportunities for sustained bluegrass seed production. High stand density may be partially responsible for seed yield decline, especially when post-harvest residue is removed mechanically. Stand suppression and thinning with spring applied Roundup may restore seed yield. No-till planting of annual crops in Roundup suppressed bluegrass stands may allow economic return during renovation.

ZONE OF INTEREST: Palouse and Camas Prairie regions of Washington and Idaho

ABSTRACT OF RESEARCH FINDINGS: Following harvest in 1998, trials were established in fields of 'Rhonde', and 'Kenblue' Kentucky bluegrass near Fairfield, WA, and in fields of 'Nublue' and 'Palouse' near Nezperce, ID, to determine whether stand suppression and thinning with Roundup can sustain bluegrass production cycles in high and low residue areas, and to determine whether an intercrop of lentil, pea, or oat, seeded into the suppressed sod would benefit this management system. Prior to spring Roundup application, bluegrass tiller density gradually increased, reaching a maximum 3 to 4 weeks prior to planting, which ranged from 424 to 877 tillers/ft^2 at the driest and wettest sites, respectively. After spraying Roundup, tiller density was 27 and 51% less in low compared to high residue treatments in 'Kenblue' and 'Nublue' fields, respectively. Tiller densities in recovering stands of bluegrass were lowest in early flowering varieties, and averaged 7, 13, 20, and 51% of control plot densities in 'Palouse', 'Kenblue', 'Rhonde', and 'Nublue', respectively. Percent bluegrass tiller recovery usually was similar between low and high residue treatments for all varieties except 'Nublue'. Later applications of Roundup usually resulted in the lower bluegrass tiller recovery. Roundup applied at 1.0 lb ai/A two weeks prior to planting intercrops suppressed bluegrass equal to or more than all other treatments. Intercrop stand density and seed yield in low residue treatments were greater than or equal to

the high residue treatments, and were negatively correlated with Kentucky bluegrass recovery. Density of bluegrass C-tillers was reduced over winter in all varieties. Bluegrass panicle densities and seed yields were lowest in plots with low C-tiller densities.

RESULTS AND INTERPRETATION: Following bluegrass seed harvest in 1998, trials were established at two locations representing four different common and proprietary varieties (Table 1). The sites near Fairfield, WA are in 'Rhonde' and 'Kenblue' fields, and near Nezperce, ID in 'Palouse' and 'Nublue' fields. Each site contains two experiments replicated four times: an intercrop experiment (experiment 1) and a herbicide experiment (experiment 2). Main plots are high and low post-harvest residue treatments and subplots are intercrops or herbicide treatments. During late August through early September, 1998, the low residue treatments were mowed, raked, and baled at the Fairfield site, and were burned at the Nezperce site, while high residue treatments at Fairfield and Nezperce were re-swathed and baled without raking. Sod cores (4-inch dia.) were collected during October and November, 1998, to determine the number of C-tillers. In experiment one, Roundup was applied at 1 lb ai/A across both residue treatments two weeks prior to no-till planting 'Phantom' leafless pea, 'Monida' oat, and 'Pardina' small brown lentil. In experiment two, eight Roundup treatments were applied across both residue treatments: 1 lb ai/A applied at 6, 5, 4, 3, and 2 weeks prior to planting the lentil, 1.5 lb ai/A applied 2 weeks preplant, and split applications of 1.0 + 1.0 lb ai/A and 0.75 + 0.75 lb ai/A applied 6 and 2 weeks before planting. Liquid AMS at 17 lb/100 gal mix was added to all Roundup treatments. The Fairfield sites were seeded using a Great Plains no-till drill with 7 inch spaced rows. The Nezperce sites were seeded using a John Deere model 750 no-till drill with 7.5-inch spaced rows. Lentil, pea, and oat were seeded at 52, 190, and 90 lb/A, respectively. All crops received 40 and 20 lb/A of P and S, respectively. Oats also received 100 lb/A N. Both experiments included non-renovated bluegrass control plots (no Roundup or intercrop) that were fertilized during fall 1998 as per the remainder of the field. During spring 1999, sod cores were taken from each plot in both experiments one week prior to spraying and two weeks after seeding the intercrops. Tiller number and type, and rhizome weight were determined. Bluegrass recovery was evaluated visually after seeding the intercrops. Crop stand counts were determined in all the intercrop experiments. Weeds and insects were monitored and controlled as needed. Panincles were counted and seed was harvested in the non-renovated bluegrass plots as well as the intercrop plots at maturity. Bluegrass hundred seed weight, and 7 and 28 day germination is being determined. Following harvest in 1999, post harvest residue was removed from the bluegrass control plots using the same methods as in 1998. Fertilizer was applied to the plot areas in October, 1999, at the same time and rate as the remainder of the bluegrass field, except in the nitrogen timing treatments. In control and lentil intercrop plots of 'Nublue' and 'Palouse', fall fertilizer was applied at 100, 70, and 30% of field rate in preparation for split spring applications of 0, 30, and 70% field rate, respectively. Density of fall tillers, which had initiated prior to harvest in 1998, (C-tillers) were determined in November 1998, and March 1999, and will continue in November 1999, and March 2000.

Objective 1: Prior to spraying Roundup, average bluegrass tiller density ranged from 424 (driest site) to 877 (wettest site) tillers/ft^2 among sites, but was uniform within a site (Table 2). Residue removal treatment did not affect the number of tillers when counted in the spring prior to spraying Roundup. However, after spraying Roundup, bluegrass tiller number was

27 and 51% less in low compared to high residue treatments in 'Kenblue' and 'Nublue' fields, respectively. Average post Roundup recovery of bluegrass tiller number was 7, 13, 20 and 51% for 'Palouse' (early flowering variety), 'Kenblue', 'Rhonde', and 'Nublue' (late flowering variety), respectively and was not affected by intercrop. Intercrop stand density and seed yield in low residue treatments was greater than or equal to the high residue treatments.

Objective 2: Pre-Roundup tiller densities usually increased with later sampling, generally reaching a maximum at 3 to 4 weeks prior to planting (Table 3). The total number of bluegrass tillers following Roundup application was not affected by residue treatment except in the variety 'Palouse' where density was 77% less in low versus high residue treatments. Percent visual recovery ranged from 15 to 19% for 'Rhonde', 'Kenblue' and 'Palouse', and was 49% for 'Nublue'. Bluegrass tiller recovery was best in high residue treatments for 'Palouse' and 'Nublue' (the low residue treatments were burned during fall 1998). Later applications of Roundup usually resulted in the least tiller recovery. Roundup applied at 1.0 lb ai/A, 2 weeks prior to planting intercrops suppressed bluegrass equal to or more than all other treatments. Lentil stand averaged about 11 plants/ft^2, and was significantly reduced by high residue in the variety 'Nublue'. Lentil seed yield was greatest in plots with the least Kentucky bluegrass recovery. Lentil seed yield was negatively correlated with both visual recovery and post-glyphosate tiller density in all varieties (Table 4). Lentil yields in low residue treatments were greater than or equal to high residue treatments. Fall C-tiller density of bluegrass in high residue treatments was greater than or equal to densities in low residue treatments in all varieties (Table 5). By spring 1999, the number of persisting C-tillers was severely reduced, especially in high residue treatments. Panicle densities were lowest in plots with low C-tiller densities. Seed yield was greatest in treatments with high panicle density.

INTERACTION WITH OTHER SCIENTISTS CONDUCTING RELATED RESEARCH: Fairfield plots were shown to the Spokane County Crop Improvement Association on June 15, 1999. The Nezperce plots were included in the Lewis County field tour on July 5, 1999.

PUBLICATIONS AND PRESENTATIONS:

Thill, D.C., G.A. Murray, and W.C. Johnston. 1999 Integrated Management System for Sustained Seed Yield of Kentucky Bluegrass Without Burning. GSCSSA Annual Report.

Murray, G.A., D.C. Thill, J.B. Swensen, and J. Reed. 1998. Integrated management system for sustained seed yield of Kentucky bluegrass without open-field burning. Western Soc. Crop Sci. ASA Abstracts, appendix 3, p.4.

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Table 1. Dates of field activities for experiments 1 and 2 at sites near Fairfield, Washington and Nezperce, Idaho.

Location	Variety	Fall 1998 KBG residue		Intercrops seeded	KBG visually estimated recovery	KBG controls swathed	KBG seed harvest	Intercrops harvested	Residue treatment applied
		High	Low						
		------lb/A------							
Fairfield	Rhonde	2742	1863	4/14/99	6/16/99	7/9/99	7/26/99	8/10 - 8/27/99	9/1 - 9/24/99
Fairfield	Kenblue	3899	1518	4/22/99	6/9/99	7/7/99	7/27/99	8/10 - 8/27/99	9/1 - 9/24/99
Nezperce	Nublue	2063	385	4/27/99	6/7/99	7/24/99	8/3/99	8/18 - 9/3/99	8/30 - 9/10/99
Nezperce	Palouse	2510	936	5/6 & 21/99	6/7/99	7/15/99	8/4/99	8/19 - 9/3/99	8/30 - 9/10/99

Table 2. Kentucky bluegrass tiller density before and after treatment with Roundup and seeding to lentil, pea, or oat intercrops in high and low levels of residue in 1999. Also included is intercrop stand density and yield.

Rhonde (Fairfield, WA)

Intercrop	Pre Roundup tillers	Post Roundup recovery[a]	Intercrop stand[b]	Intercrop yield
	no/ft^2	%	no/ft^2	lb/A
Lentil	703	18	9	523
Pea	632	19	8	1040
Oat	785	24	38	1671
LSD	NS	NS	4	292
Residue				
High	708	19	19	1114
Low	706	21	18	1042
LSD	NS	NS	NS	NS

Kenblue (Fairfield, WA)

Intercrop	Pre Roundup Tillers	Post Roundup recovery[a]	Intercrop stand[b]	Intercrop yield
	no/ft^2	%	no/ft^2	lb/A
Lentil[c]	390	13	9	410
Pea	560	14	9	830
Oat*	322	12	37	1157
LSD	NS	NS	2	205
Residue				
High	339	15	16	788
Low	509	11	16	810
LSD	NS	4	NS	NS

* Gross sample weight, which includes wild oat seed. These samples are being cleaned.

Table 2. Continued

Nublue (Nezperce, ID)

Intercrop	Pre Roundup tillers	Post Roundup recovery[a]	Intercrop stand[b]	Intercrop yield
	no/ft^2	%	no/ft^2	lb/A
Lentil[c]	702	50	10	497
Pea	791	54	7	706
Oat	635	48	49	2678
LSD	NS	NS	5	285
Residue				
High	668	67	16	747
Low	750	33	23	1442
LSD	NS	7	8	91

Palouse (Nezperce, ID)

Intercrop	Pre Roundup tillers	Post Roundup recovery[a]	Intercrop stand[b]	Intercrop yield
	no/ft^2	%	no/ft^2	lb/A
Lentil[c]	1023	7	14	1176
Pea	746	6	7	1424
Oat	861	8	42	4071
LSD	NS	NS	4	316
Residue				
High	845	7	19	1935
Low	908	7	19	1988
LSD	NS	NS	NS	NS

[a] Visual recovery is percent of control stand density.
[b] Intercrop stand counts taken 6 to 9 weeks after seeding.
[c] All the experiments included twice as many lentil plots as pea and oat except the Rhonde site.

Table 3. The effect of Roundup rate and timing on Kentucky bluegrass tiller number, and lentil stand and yield in four varieties of Kentucky bluegrass, with high and low levels of post-harvest bluegrass residue in 1999.

Rhonde (Fairfield, WA)

Roundup rate	Application timing	Pre Roundup Total tillers	Post Roundup Total tillers	Post Roundup Visual recovery[b]	Lentil stand	Lentil yield
lb ai/A	weeks[a]	no/ft^2	no/ft^2	%	no/ft^2	lb/A
1	6	244	400	27	12	96
1	5	395	523	23	13	263
1	4	488	525	26	10	219
1	3	537	341	19	9	312
1	2	596	151	9	8	462
1.5	2	458	205	8	10	709
1,1	5,2[c]	289[d]	259	7	9	559
0.75, 0.75	5,2[c]	357[d]	258	10	12	355
	LSD	212	91	6	4	182
Residue						
High		405	354	16	10	364
Low		436	341	16	11	402
LSD		NS	NS	NS	NS	NS

Kenblue (Fairfield, WA)

Roundup rate	Application timing	Pre Roundup Total tillers	Post Roundup Total tillers	Post Roundup Visual recovery[b]	Lentil stand	Lentil yield
lb ai/A	weeks[a]	no/ft^2	no/ft^2	%	no/ft^2	lb/A
1	6	202	487	44	10	100
1	5	335	390	51	8	66
1	4	398	324	23	9	212
1	3	665	146	6	10	346
1	2	469	138	6	10	373
1.5	2	421	89	4	8	403
1,1	6,2	340[d]	116	9	10	352
0.75, 0.75	6,2	301[d]	216	8	9	311
	LSD	174	120	5.3	NS	115
Residue						
High		328	227	20	9	264
Low		469	249	18	9	277
LSD		NS	NS	NS	NS	NS

Table 3. Continued

Nublue (Nezperce, ID)

Roundup rate	Application timing	Pre Roundup Total tillers	Post Roundup Total tillers	Post Roundup Visual recovery [b]	Lentil stand	Lentil yield
lb ai/A	weeks[a]	no/ft^2	no/ft^2	%	no/ft^2	lb/A
1	6	377	1206	70	11	193
1	5	520	847	63	13	303
1	4	630	849	61	11	296
1	3	715	698	53	14	440
1	2	955	321	36	14	582
1.5	2	861	162	28	10	750
1,1	6,2	769[d]	235	41	10	650
0.75, 0.75	6,2	659[d]	517	44	9	560
	LSD	NS	380	11	NS	176
Residue						
High		630	732	65	9	232
Low		741	431	33	14	712
LSD		NS	NS	17	2	177

Palouse (Nezperce, ID)

Roundup rate	Application timing	Pre Roundup Total tillers	Post Roundup Total tillers	Post Roundup Visual recovery[b]	Lentil stand	Lentil yield
lb ai/A	weeks[a]	no/ft^2	no/ft^2	%	no/ft^2	lb/A
1	6	1259	266	27	14	925
1	5	1116	192	31	15	1023
1	4	676	179	23	13	1097
1	3	1230	106	6	12	1250
1	2	937	37	7	13	1440
1.5	2	895	103	5	11	1316
1,1	6,2	593[d]	59	6	13	1436
0.75, 0.75	6,2	310[d]	73	10	16	1465
	LSD	548	96	11	NS	455
Residue						
High		785	207	19	12	1175
Low		984	47	10	15	1313
LSD		NS	147	9	NS	111

[a] Weeks prior to planting intercrop.

[b] Percent of control stand density.

[c] First application made 5 weeks prior to planting due to weather.

[d] Tiller density is for the second application.

Table 4. Correlation coefficients of the relationship of post-Roundup recovery in four Kentucky bluegrass varieties asssessed both visually and as tiller density, with lentil stands and seed yield. Significance of the correlation coefficient is denoted by: * P=0.05; ** P=0.01; *** P=0.001.

Variety	Variable	Visual recovery	Tiller density	Lentil stand
Rhonde	Tiller density	0.49***	--	--
	Lentil stand	0.22	0.24	--
	Lentil yield	-0.51***	-0.48***	-0.22
Kenblue	Tiller density	0.75***	--	--
	Lentil stand	-0.9	-0.16	--
	Lentil yield	-0.77***	-0.63***	0.11
Nublue	Tiller density	0.65***	--	--
	Lentil stand	-0.30*	-0.19	--
	Lentil yield	-0.84***	-0.59***	0.38**
Palouse	Tiller density	0.60***	--	--
	Lentil stand	-0.02	-0.13	--
	Lentil yield	-0.39**	-0.38**	-0.05

Table 5. The effects of high and low post-harvest residue on C tillers, panicle density, and seed yield of four Kentucky bluegrass varieties.

Variety	Residue	Fall 1998 C tillers	Spring 1999 C tillers[a]	Panicle density	KBG seed yield
		-----------------no/ft^2-----------------			lb/A
Rhonde	High	302	6	42	100
	Low	319	23	59	113
	LSD	NS	NS	NS	NS
Kenblue	High	239	0	21	21
	Low	256	0	25	36
	LSD	NS	NS	NS	10
Nublue	High	684	49	143	162
	Low	163	189	323	245
	LSD	124	122	43	15
Palouse	High	416	146	156	166
	Low	339	301	236	272
	LSD	NS	NS	51	69

[a] Pre Roundup counts.

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December 3, 1998

FILE COPY

MEMORANDUM

TO: Shawn Nolphe

FROM: Glen Murray GAM

SUBJECT: Summary of Progress on Project Funded by Ag Task Force Funds:

As per your request by phone on December 2, I have summarized the progress on our work on bluegrass. The first page of this report is a **proposal** summary that may be of benefit for the committee to review before looking over the Progress that follows. On the last page I have identified two issues for consideration by your group. If you need additional information, please let me know.

Proposal Summary

Project Title: Integrated Management System for Sustained Seed Yield of Kentucky Bluegrass Without Open-field Burning

Rationale. About 125,000 acres of Kentucky bluegrass seed provides $62,500,000 to growers in the Pacific Northwest. Total value to the regions economy is $100,000,000. In addition to adaptation to rolling Palouse terrain, bluegrass reduces soil erosion, improves water quality, and requires fewer pesticides than many annual crops. Potential elimination of open-field burning in Washington and opposition to smoke in Idaho and Oregon may reduce acreage and economy.

Bluegrass seed production systems have evolved with burning as an option. New non-burn management systems must consider variety choice, crop rotations, and environment.

Background. Without burning, the consecutive number of seed crops decline from ten or more to two depending on precipitation, cultivar, stand density, and residue remaining after harvest. Suppression of bluegrass with spring applied Roundup and no-till planting of annual crops in suppressed bluegrass stands may allow economic return during renovation, allow additional bluegrass seed crops without replanting, and reduce environmental impact of conventional annual cropping.

Bluegrass cultivars respond differently to Roundup application, post-harvest residue removal, and nitrogen management. With mechanical residue removal, no data are available on bluegrass seed yields after no-till annual cropping on suppressed bluegrass. No-till annual cropping in Roundup suppressed bluegrass stands has been successful with lentils and barley.

Knowing when to renovate bluegrass stands would be of economic value to growers. High proportions "C" and "F" tillers in fall and spring and good fall floral induction are essential for good seed yield. Timing nitrogen application to enhance production of productive tillers and floral induction will fur... enhance seed yield potential in the abs...ce of burning.

Overall Objective: To extend seed production cycles of Kentucky bluegrass without open-field burning of post-harvest residue by chemical renovation and no-till annual cropping, and nitrogen management.

Procedure: Roundup suppression of bluegrass in the spring and no-till annual cropping of lentil, mustard, and barley will be evaluated at three locations to extend seed production cycles of Kentucky bluegrass without open-field burning. Residue will be removed from bluegrass fields by either baling and flailing or baling, flailing, and raking. Propane flaming will be substituted for raking in the later treatment in Idaho in Washington, if approved as an option for use. Nitrogen application will be timed to enhance productive tiller development and fall floral induction. Relating proportion of "C" and "F" tillers before and after chemical renovation, and on bluegrass without either Roundup application or annual crop, to seed yield may allow prediction of yield potential. Yield estimates will aid decisions on timing of bluegrass renovation. Information will be disseminated to growers via field representatives, extension educators, field tours, and practical publications and to scientists via meetings and journal publications.

Progress

Integrated Management System for Sustained Seed Yield of Kentucky Bluegrass Without Burning

Locations: Field plots were established at three dryland locations, two in Spokane County of eastern Washington, (Chad Denny and Greg Wernz farms), and one in Lewis county of northern Idaho, (Jim Zenner farm). At the Zenner farm, two experiments were established, each on a different bluegrass variety.

Bluegrass varieties:	Eastern Washington:	Denny Farm:	Rhonde. Wernz Farm: Kenblue
	Northern Idaho:	Zenner Farm:	Palouse and NuBlue

These varieties are commonly raised at these locations and should provide a good representative cross section of genotype responses to the various alternative management treatments.

Fall Residue Management. The residue removal treatments are designed to leave two levels of residue on the soil surface. The bale only treatments leaves the most residue but is the cheapest method, and if it will work with certain variety-location situations will be an operation of choice for growers. Re-swathing and baling was the other residue removal treatment. Because of grower equipment availability, other treatments approximating re-swathing and baling were used on the Wernz farm. (See table on next page) The bale plus propane treatment was not applied because of the difficulty in obtaining a permit through SCAPA (See items for consideration later). In northern Idaho, re-swath and bale, and open field burn were used. At all locations, each residue management treatment is replicated four times.

Fall Fertilization: Control plots that will remain in bluegrass for the duration of the experiment were fertilized with commercial equipment at normal commercial rates on Oct 21 in eastern Washington and Oct 7 in northern Idaho.

Plant and soil samples: Plant samples were taken from all locations after fall green-up to assess "C" and "F" tiller development. Soil moisture samples were taken after residue management treatments were applie , and periodically during the fall growing season. The data from the tiller counts are still being summarized. The table below summarizes the residue load remaining after the residue management treatments were applied. Soil moisture samples were taken on Sept 6.

Location and Variety	Residue treatment	Residue Load	Gravimetric soil moisture 0-3"	3-6"	6-12"
		lb/acre	%		
Nezperce:					
Palouse	Reswath & bale	2510	22	22	22
Palouse	Open field burn	936			
Nublue	Reswath & bale	2063	15	11	12
Nublue	Open field burn	385			
Fairfield:					
Rhonde	Reswath & bale	2740	5	8	10
Rhonde	Reswath, bale, rake	1860			
Kenblue	Bale only	3900	3	3	3
Kenblue	Bale, mow, rake	1520			

Future Work: Roundup treatments will be applied in the spring and three annual crops no-till planted about two weeks after the last roundup treatment. After harvest of the annual crops, nitrogen treatments will be applied to the bluegrass and normal management of bluegrass continued until two additional bluegrass seed crops are harvested. Field days will be held in early July 1999 to view annual crops, and June of subsequent years to view bluegrass responses.

Future Items For Consideration:

1. **Wash. DOE and SCAPA Cooperation.** Propane treatment: To apply this treatment required the same application process that growers use. If the grower had already used an emergency exemption for one-third of his acres no permit would be issued for the propane treatment. Also since only one exception is allowed for the life of that field, we would not have been allowed to propane burn that treatment again as needed in subsequent years. Suggestion: Better cooperative arrangements with SCAPA to allow research treatment applications approved by state agencies.

2. **Funding:** The Coeur d' Alene tribe did not contribute the $7,000 they (Gary Greenwell) indicated that funds would be available for additional work in their area. Thus no trials were established on the reservation.

   This grant proposal has been submitted to GSCSSA (Grass Seed Cropping Systems For Sustainable Agriculture–a tri-state grass group with USDA-CREES Funding Source) and STEEP III for partial funding to help ensure completion of this trial. The proposal submitted to GSCSSA was recommended for funding by the technical and industry committees of that group. Final funding approval is made by the administrative committee and is expected soon. The funding status for the proposal submitted to STEEP III won't be known until later, March?.

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Submitted To: Agricultural Burning Practices and Research Task Force

Funding:

1998	$10,290
1999	$51,275
2000	$52,007
2001	$41,190

Project Contact: and Coordinators:

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Major Participants: Glen Murray, Donn Thill, Bill Johnston, Jeff Griffin, John Hammel, Anne Sylvester, Jerry Sitton

Cooperators:

Three **growers**, one dryland in eastern Washington, Spokane County; one dryland in northern Idaho, Kootenai or Lewis County, and one irrigated in northern Idaho, Kootenai County.

Field Representatives and Industry:

Heart Seed:	Paul McCathern
Dye Seed:	Bill Ruchert or Larry Lampert
Seeds Inc:	Dave Toleson
Jacklin Seed Co:	Skip Allert
Cenex:	Mark Lonam, Dave Asher, or Charley Gresham.

Extension:

Vacant.	Agricultural Agent, Spokane County
Vickie Parker-Clark	Extension Educator, Kootenai County
Ken Hart	Extension Educator, Lewis County Agent
Dave Bragg	Agricultural Agent, Garfield Co.

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Bluegrass cultivars respond differently to Roundup application, post-harvest residue removal, and nitrogen management. With mechanical residue removal, no data are available on bluegrass seed yields after no-till annual cropping on suppressed bluegrass. No-till annual cropping in Roundup suppressed bluegrass stands has been successful with lentils and barley.

Knowing when to renovate bluegrass stands would be of economic value to growers. High proportions of "C" and "F" tillers in fall and spring and good fall floral induction are essential for good seed yield. Timing nitrogen application to enhance production of productive tillers and floral induction will further enhance seed yield potential in the absence of burning.

Overall Objective: To extend seed production cycles of Kentucky bluegrass without open-field burning of post-harvest residue by chemical renovation, no-till annual cropping, and nitrogen management.

Procedure: Roundup suppression of bluegrass in the spring and no-till annual cropping of lentil, mustard, and barley will be evaluated at three locations to extend seed production cycles of Kentucky bluegrass without open-field burning. Residue will be removed from bluegrass fields either by baling and flailing, or by baling, flailing, and raking. Propane flaming will be substituted for raking in the latter treatment in Idaho and in Washington, if approved as an option for use. Nitrogen application will be timed to enhance productive tiller development and fall floral induction. Relating the proportion of "C" and "F" tillers before and after chemical renovation, and on bluegrass without either Roundup application or annual crop, to seed yield may allow prediction of yield potential. Yield estimates will aid decisions on the timing of bluegrass renovation. Information will be disseminated to growers via field representatives, extension educators, field tours, and practical publications and to scientists via meetings and journal publications.

Project Narrative

Background or Problem addressed: Non-burning bluegrass seed production systems will reduce the number of consecutive bluegrass seed crops from ten or more to two crops. More frequent establishment, increased potential for soil erosion, and increased populations of annual grass weeds will further decrease sustained economic production. A management system is needed to renovate established stands and no-till annual crops between two year cycles of bluegrass seed. Prediction of when to renovate the stand based on seed productivity potential is essential. Successful chemical renovation could increase the number of bluegrass seed crops without replanting, reduce annual grass and broadleaf weeds, reduce erosion potential, and increase economic return in the absence of burning.

Current and Related Work:

Mechanical Residue Removal. Two to three seed crops of Kentucky bluegrass have been successfully produced following mechanical removal of post harvest residue in Idaho and Washington (Murray,1993, Murray and Swensen, 1994, 1995, Murray and Johnston, 1994, 1995) and in Oregon, (Chastain, et al., 1994,1998). However, mechanical removal of post harvest residue will reduce the consecutive number of seed crops compared to burning (Canode and Law, 1977, Chilcote et. al., 1980, Ensign, 1980, Murray, 1993, Murray and Swensen, 1994, 1995) and is more expensive than burning (Hinman, OSU Pub). Chastain et al.(1994, 1998) also found that crewcut-vacuum sweeping and needlenose raking have provided seed yields similar to open-field burning in the Grande Rhonde Valley near LaGrande. Baling and flailing were less effective than more thorough residue removal treatments, especially in older stands. In central Oregon, Coats et al.(1994) reported similar results, and the effectiveness of mechanical residue removal again declined as stands aged. In the fourth seed year, seed yields of Abbey and Rugby were 15 to 20% less than yields with open-field burning.

Bluegrass cultivars respond differently to mechanical residue removal (Murray, 1996, Murray and Swensen, 1994, 1995). Seed yields of aggressive, elite varieties usually decline more rapidly than yields of non-aggressive common varieties. Increased stand density partially causes decreased seed yields as stands age, especially when post-harvest residue is removed mechanically. Cultivars with long fall floral induction requirements produced 79% less seed than cultivars with short floral induction requirements when dry fall conditions delayed fall regrowth and completion of floral induction (Murray et al., 1997a, 1997b).

Floral Induction, Tiller Category and Seed Yield. Kentucky bluegrass must reach a minimum growth stage or size to be receptive to vernalization. Completion of this growth phase marks the transition from a juvenile to an adult plant. The length of the juvenile phase varies with cultivar and plant age. Carlson et al. (1995) found that the cultivar 'Midnight' needed 13 weeks of growth and 13 weeks of vernalization for floral induction while the cultivar Park only required three to five weeks of growth and three weeks of vernalization. Parker-Clark et al. (1994) and Parker-Clark (1997) found that bluegrass seedlings must have a minimum of six to nine leaves to complete the juvenile phase of growth. Glade required more leaves than Huntsville to complete the juvenile phase. In addition, bluegrass seedlings passed through three morphological-anatomical stages during the juvenile phase.. It is unknown whether bluegrass must pass through all of these phases to be receptive to vernalization. Correlating receptiveness to vernalization with plant growth stage from field-grown samples could allow more accurate timing of nitrogen fertilizers for enhanced floral induction and seed yield.

Completion of the juvenile phase of seedling bluegrass can be predicted by leaf width, vascular bundle number, and other cell characteristics (Parker-Clark, 1997). Bluegrasss seed yield potential has been predicted on the basis of the proportion of tiller classes present in the fall and spring (Sylvester, 1997). The most productive "C" tillers are formed in the year previous to seed production. The "F" tillers also contribute to yield but are formed in the fall preceding the harvested seed crop. Panicles from the "F" tillers have fewer spiklets and florets and are smaller than those from the "C" tillers. Proper timing of residue removal and nitrogen application may improve productive tiller numbers and enhance seed yield in the absence of burning.

Nitrogen Management. Mahler and Ensign (1989) found that fall application of N was more effective than early spring N application for increased seed yields. Fall N application stimulates fall regrowth needed for the tiller development previously described. Early spring nitrogen application may reduce yield because of stimulated vegetative growth. The best timing of fall and spring N application relative to potential "C" and "F" tiller development, fall floral induction, and cultivar requirements are unknown. Nitrogen application at early stem extension enhanced productive potential in commercial trials near Fairfield, WA (Personal communication, John Cornwall, Mt.Hope-Fairfield grower).

Work in Norway (Aamlid, personal conversation) showed that some Kentucky bluegrass cultivars produced better seed yield when fertilized in August while others produced better seed yield if fertilized in September. Nelson (1985) also found that bluegrass cultivars responded differently to timing and rate of N application.

In Canada, Thompson and Clark (1993) showed that 'Nugget' Kentucky bluegrass close-clipped to one inch produced smaller inflorescences with fewer spikelets than bluegrass clipped to a height of 3 inches. However, 112 lb N/acre applied prior to vernalization of' bluegrass at 36 F increased the proportion of tillers with large basal diameter, ultimately resulting in more panicle production than if nitrogen was not applied. This may partially explain why N applied only in the spring does not improve yield as much as fall applied N.

High N levels have been shown to delay floral induction and maturity in other plants. Timing of N application relative to juvenility and vernalization may influence timing and degree of fall floral induction and subsequent seed yield. Since fall floral induction requirements have been shown to be cultivar dependent (Murray, 1993, 1994, Murray et al., 1992, Canode and Perkins, 1977), timing of fall nitrogen application may influence fall floral induction and subsequent panicle expression.

Stand Thinning. Evans (1980) found that gapping (removal of alternate nine-inch sections of rows) increased seed weight per panicle of 'Cougar' Kentucky bluegrass by 12% the first year and panicles per row and seed yield up to 39 and 32% in the second year. Evans and Canode (1971) found comparable second, third, and fourth-year seed yields of Newport Kentucky bluegrass when burned or when gapped by removing alternate 30 cm sections of rows.

Gapping and nitrogen level interactions existed (Evans and Canode, 1971). Panicle numbers were reduced more by high rates of nitrogen than by low rates of nitrogen. At high levels of N, 179 kg per hectare or more, seed yields of gapped and ungapped bluegrass were not different.

Gapping reduced panicle numbers compared to burning, but seed weight per panicle increased (Evans and Canode, 1971). Seed weight per panicle from unburned bluegrass (gapped and ungapped) responded little to N rates above 200 lb/acre. However, seed weight per panicle was consistently greater for gapped than for ungapped bluegrass at all N rates. These data indicate something more than just nitrogen was involved in the gapping response. Neither gapping nor burning prevented seed yield decline with stand age.

Diseases and Insects. Silvertop, *Drechslera poae* (leafspot and especially melting out), ergot, rust, and powdery mildew are potential problems with and without burning (Johnston et al., 1996). *Drechslera* and Silvertop are dryland and irrigated problems and both are becoming more of a problem without burning (Johnston and Sitton, 1996). Ergot, rust and mildew are more of a problem with irrigation but can be problems under dryland conditions depending on cultivar and environmental conditions. Silvertop and ergot incidence may be interrelated with the incidence of insect vectors.

Field representatives have reported increased sod webworm infestations in non-burned fields. Little research is available on control of sod webworm in non-burned fields. Silvertop is caused by *Fusarium poae*, but may be initiated by insect vectors or insect damage.

Chemical Renovation. With open-field burning of bluegrass residue, Roundup suppression and and no-till annual cropping has ben successfull with lentil (Dave Mosman, Nezperce grower), and with barley (Becker, Colton grower). In a five-year old bluegrass variety trial, with post-harvest residue removed mechanically for four years, Murray et al. (1997) found that lentils no-tilled into Roundup-suppressed bluegrass produced yields of 569 to 1064 pounds per acre. Lentil yield was dependent on bluegrass variety. One quart of Roundup per acre provided optimum suppression of most bluegrass varieties for good lentil yield. Subequent bluegrass seed yield will be available from these trials in 1998-1999.

Conclusions and Overall Objective. The combination of chemical grass suppression and no-till planting will provide soil protection compared to mechanical tillage of bluegrass and planting an annual crop. Timing and rates of Roundup application relative to spring regrowth, location, no-till annual crop yields of lentils, mustard, spring barley and subsequent bluegrass seed yields are not adequately known. This study proposes to utilize existing grower experience and evaluate Roundup for stand renovation and no-till annual cropping as a means of extending productive stand life of Kentucky bluegrass without burning of post-harvest residue.

Overall Objective: To extend seed production cycles of Kentucky bluegrass without open-field burning of post-harvest residue by chemical renovation and no-till annual cropping.

Specific Objectives:

1. To measure cultivar and location influence on Roundup suppression of bluegrass, seed yield

of three no-till annual crops, subsequent bluegrass seed yield for two years, and nitrogen response.

2. To relate bluegrass seed yield responses to Roundup rate and timing, timing of nitrogen application, proportion of productive tiller categories, and fall floral induction.

3. To disseminate information to growers via cooperating field representatives, extension educators, field tours, and practical publications and to scientific audiences via scientific publications and presentations.

Approach:

Materials and Methods:

Three locations will be selected, two dryland and one irrigated. Selection criteria for field sites will be based on grower interest and participation, bluegrass variety, and stand age. Growers with interest in no-till annual cropping and access to no-till drills, fields with bluegrass varieties important to the area, and fields producing the second seed crop in 1998 will be given top priority.

After harvest of the second seed crop, two experiments will be conducted simultaneously in each field. First and second-year seed yield and cropping rotation history will be obtained from each field. Experiment one will measure the influence of bluegrass suppression with Roundup herbicide, cultivar, location, and nitrogen management on seed yield of bluegrass for two years following no-till planting of lentils, mustard, and spring barley compared to a no renovation control. Experiment two will measure the influence of two roundup rates and two timings of roundup application on bluegrass supression, no-till spring crop seed yield (same crop as planted by grower in the field), and subsequent bluegrass seed yield for two years.

Additional on-farm trials may be conducted depending on industry and grower interest. Principle investigators would help plan and analyze data from these trials. These trials may expand chemical renovation data on bluegrass cultivar and location influence and no-till annual cropping base to peas, spring wheat, and winter wheat.

Experiment one: Main plots in this experiment will be two methods of residue removal, bale and flail, and either bale, flail, and rake or bale and propane flaming. In Washington, propane flaming will be used only if approved as an option for growers to use. In Idaho, propane flaming will be used instead of bale, flail, and raking. Roundup will be spring applied to the entire area to be recropped. The main plots will be subdivided into three annual crop strips. After harvest of the annual crop, the annual-cropped plots will be further subdivided to receive nitrogen applications at four times. Application times will be 70% fall, 30% early spring; 70% fall, 30% at stem extension in spring; 100% fall; 30% fall and 70% at stem extension in spring.

1. To measure cultivar and location influence on roundup suppression of bluegrass, seed yield of three no-till annual crops, and subsequent seed yield of bluegrass for two years.

After harvest in 1998, post-harvest residue will be removed by baling and the remaining stubble either flailed or propane burned (Johnston). Fall regrowth will be characterized into tiller categories (Sylvester), rhizome biomass, and total tiller number (Murray-Thill) from plant cores taken in October. Additional plant cores will be removed from the field periodically from October through April, transplanted to greenhouse conditions of 18-hour photoperiods and temperatures of 65 to 75 F, and floral induction measured by panicle expression (Griffin).

In spring 1999, Roundup will be applied to the entire plot area, except the non-renovated bluegrass control plots, at 1.0 quart per acre after bluegrass begins regrowth and at least two weeks prior to no-till planting of annual crops. One week before and two weeks after roundup application, plant cores will be taken to estimate tiller number, rhizome biomass, and above ground regrowth.

Lentils, mustard, and spring barley will be no-till seeded in April, 1999 across both residue management treatments. Annual crops will be fertilized with phosphorus and small amounts of nitrogen and sulfur during no-till seeding. The remaining N needed will be broadcast on the soil surface. Bluegrass regrowth will be monitored visually from planting to harvest of the annual crops. Plant population will be counted in each annual crop two weeks after emergence. Weeds, insects, and diseases of the annual crops will be monitored and controlled as appropriate. Seed yield of annual crops and non-renovated bluegrass will be measured by harvesting 4 foot by 20 foot strips from the center of each plot.

Post-harvest residue from the annual crop and the bluegrass control plots will be removed by baling in August, 1999. Stubble remaining after baling will be removed by either flailing or propane burning in the same plot areas that received these treatments after harvest of the second bluegrass seed crop in 1998.

Experiment two. (Thill) Suppression and/or control of Kentucky bluegrass with different rates and timings of Roundup will be determined in separate studies at each field location. Main plots will be the same as described in experiment one. Roundup treatments will be applied soon after bluegrass plants resume active growth in the spring, and immediately before emergence of the annual crop seeded into the bluegrass stand. Herbicide treatments will be 1.0, 1.5, 1.0 + 1.0 (right before crop emergence), and 0.75 + 0.75 (same as previous treatment) lb ai/A. All Roundup solutions will contain 1 to 2% ammonium sulfate w/v. A control plot without either Roundup application or annual crop will be included. The 15 by 25 ft sub-plots will be arranged as a randomized complete block with four replications (about 0.4 acres per site). The annual crop will be determined by the cooperating growers. Bluegrass suppression and control will be determined visually 30 and 60 days after the first treatments are applied. Bluegrass sod cores will be collected 1 week before and 2 weeks after the final treatments are applied, and in the fall following harvest of the annual crop. Regrowth will be determined in the greenhouse as described previously. The annual crop and control bluegrass plot will be harvested at maturity with a small plot combine and clean seed yield determined. All crop post-harvest residue will be baled and then either flailed or propane burned as described previously. Bluegrass seed yield will be determined during the next two growing seasons as described previously.

2. To relate bluegrass seed yield to timing of nitrogen application, "C" and "F" tiller

populations, fall floral induction and previous spring annual crop.

(Hammel) In fall 1999 and 2000, nitrogen, phosphorus and sulfur will be applied as described previously. Soil tests will be taken in the fall prior to N application to determine residual soil N and to determine N rates for the bluegrass. In the spring, at beginning of regrowth and at harvest, soil samples will be taken to determine efficiency of N use. Seed yield will be related to total N use, N timing, and efficiency of N utilization.

(Sylvester) Plant cores taken from each plot will be categorized for proportions of "C" and "F" tillers. The proportion of tillers in each cultivar, location, residue removal method, and N timing treatment will be related to seed yield. Regression equations will be developed to determine if seed yield can be predicted from tiller composition. "C" and "F" tillers will be categorized and related to nitrogen timing.

(Griffin) Additional plant cores will be collected periodically from October through April. Each plant sample will be characterized for plant growth stage with respect to tiller number, number of leaves per tiller, and total biomass. One half of the cores will be transplanted into the greenhouse as previously described to measure floral induction. The remaining half will be placed in vernalization chambers with alternating temperatures of 36 to 50F and eight-hour photoperiods, followed by transfer to the greenhouse, to determine the timing of the transition from the juvenile phase to the adult phase. The timing of this transition and the timing of N application will be related to seed yield. It is expected that high N application during the juvenile period will delay plants from completing the juvenile phase, thus delaying completion of floral induction and ultimately reducing seed yield. The relationship between the timing of floral induction and the time of nitrogen application will be evaluated.

3. To monitor effects of residue management and no-till annual cropping on disease and insect development, develop threshold levels, evaluate control measures, and seek pesticide registration for control. (Special emphasis on Silvertop, ergot, and sod webworm)

(Johnston-Sitton) The severity of ergot, silvertop, rust, powdery mildew, and *Drechslera* leaf disease will be monitored for selected fields and treatments in bluegrass after harvest of annual crops. *Claviceps purpurea* will be disease indexed in the field and panicles will be sampled to determine sclerotia number and sclerotia weight per panicle (Johnston et al., 1996). Silvertop disease indexing will be done by counting the number of whiteheads per sq. m and diseased plants will be taken for laboratory fungal isolation and microscopic examination. *Fusarium poae* will be isolated by dissecting the diseased tissue, transferring directly to Nash and Snyder *Fusarium* selective media (1962), and then to potato dextrose agar. Identification of *Drechslera* sp. will be according to Gray and Guthrie (1977). *Puccinia graminis* f sp. *poae* and powdery mildew severity will be determined by use of a visual disease index. The crop strip seeded to cereal will be assessed for severity of *Rhizoctonia*. Infection will be determined by root symptom observation and isolation on agar media (Weller et al., 1986). The effect of previous and present bluegrass residue management regimens on diseases and yield will be evaluated and threshold levels will be developed when possible.

(Bragg) Irrigated, and potentially dryland, bluegrass fields will be sampled to identify insect species active during bluegrass flowering and carrying conidia of *C. purpurea*. Collection procedures will include sweeps, soil samples, use of a Schan shaker, and black light traps. Samples will be evaluated to confirm and quantify the presence of ergot conidia by S. Alderman (UDSA/ARS). Identification of insects will be determined by G. Fisher (OSU) and/or D. Bragg (WSU). Selected treatments within the chemical renovation trial and other fields will be evaluated for sod webworm population levels. Liquid and granulated formulations of pesticides will be compared on burned and non-burned plots for sod web worm control in separate trials. Insect threshold levels will be developed when possible.

Anticipated Schedule:

Summer 1998	Identify field sites, grower cooperators, meetings to fine tune experimental detail.
Fall 1998:	After bluegrass harvest, bale bluegrass residue, lay out field plot design, apply residue management treatments. October: Collect plant data on tiller categories and rhizome biomass, Periodically collect plant cores October through April for floral induction measurements.
Spring 1999:	Roundup application and no-till planting of annual crops. Also collect bluegrass plant data on tiller categories and floral induction prior to and after Roundup application.
Summer 1999:	Collect annual crop data. Field Tours for growers, field representatives, agencies, legislators.
Fall 1999:	Harvest annual crops. Apply residue management treatments. Apply N treatments, collect plant cores for tiller categories, rhizome biomass, fall floral induction
Winter 1999	Meetings. Growers, field representatives, agencies, legislators. Annual Intermountain Grass Growers Association, Nezperce Grass Growers Asssociation.
Spring 2000:	Collect plant cores for tiller categorization, rhizome biomass.
Su-Fall 2000:	Field tours. Harvest bluegrass. Apply residue management treatments. Apply N treatments, collect plant cores for tiller categories, fall floral induction
Winter 2000	Meetings. Growers, field representatives, agencies, legislators.
Spring 2001:	Collect plant cores for tiller categorization, rhizome biomass.
Summer 2001:	Field Tours. Harvest bluegrass.
Fall 2001:	Analyze data, publish scientific and practical publications. Disseminate to grower groups, agencies, and other interested parties.

Budget and Justification:

See anticipated schedule for justification. Note the first two years of funding are needed for this project in order to begin work. Most costs are associated with sample collection and processing.

	Year				
	1998	1999	2000	2001	Total
Personnel					
Research Assoc. 3-6% time	1,000	2,000	2,000	2,000	$7,000
Scientific Aide ½ time		11,000	11,550	12,128	$34,678
Technical Support	2,000	2,000	2,000	2,000	$8,000
Hourly Employees	3,000	16,500	16,500	12,000	$48,000
Fringe Benefits	1,290	6,875	7,057	6,662	$21,884
Operating Expenses	2,000	9,500	9,500	3,000	$24,000
Travel	1,000	3,400	3,400	3,400	$11,200
Total	$10,290	$51,275	$52,007	$41,190	$154,762

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Vitae

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B.S. Range Management	1962	Montana State College
M.S. Agronomy	1964	Montana State College
PhD Agronomy-Crop Physiology	1967	University of Arizona

Research and Teaching Specialities. Kentucky bluegrass seed production without burning of post-harvest residue; floral induction of Kentucky bluegrass. Co-developed Tri-State Grass Seed Cropping Systems for Sustainable Agriculture (GSCSSA) Grant and tri-chair of GSCSSA. Previous: Establishment limitations and winter hardiness of Austrian winter peas, planting requirements, nutrition, and adaptation of winter rapeseed, winter and spring cereals, spring peas, spring lentils, and alternate crops including safflower, sunflower, crambe, flax, meadowfoam, and mustard. Author or co-authored 150 research and extension publications, 2 book chapters, 6 symposia articles. Teach senior graduate level courses in Field Crop Production and Crop Physiology.

Service: Liaison for College of Agriculture; Id. Seed Council, and Id. Eastern Ore. Seed Assoc Intermountain Grass and Nezperce Prairie Growers Assoc. Numerous committees.

Professional Associations.
American Society of Agronomy
Western Society of Crop Science
Gamma Sigma Delta

Honors and Awards:

American Society of Agronomy Nominee from Western Region for President	1996
Western Society of Crop Science President Elect, President	1981-82, 1982-83
Pacific Seed Association. Man of The Year Award	1993
Outstanding Teacher, University of Idaho	1992
Phi Kappa Phi Distinguished Faculty Award	1983
Assoc. Students Outstanding Faculty Award	1982
Outstanding Teacher, College Of Agriculture	1979
Outstanding Student Counselor Award, College of Agriculture.	1979
Gamma Sigma Delta, Outstanding Research Award, President, Treasurer	1991, 1974, 1973

Selected Publications. Also see literature cited section in this proposal.

Current and Pending support.

Grass Seed Cropping Systems For Sustainable Agriculture

Investigators	Project Title	Period	Amount
Murray, G,.Thill,D	Chemical Renovation and No-Till Annual Cropping of Kentucky Bluegrass Seed Fields	1996-98	21420
Murray, G	Cultivar Response to Residue Management and Nitrogen Timing	1997-00	24812
Murray, G. Johnston, W.	Cultivar Identification and On-Farm Technology For Sustained Kentucky bluegrass Seed Produciton	1995-98	50000

CURRICULUM VITAE

Name: Donald C. Thill
Rank: Professor of Weed Science
Address: Dept. of Plant, Soil, and Entomological Sciences, Univ. of Idaho, Moscow, ID 83844-2339.
Office phone: (208) 885-6214
FAX: 208-8857760
email: dthill@uidaho.edu

Education:

B.S., Agronomy, 1972, Washington State University, Pullman, WA

M.S., Agronomy, 1976, Washington State University, Pullman, WA. (Major advisor - Dr. Robert Witters, College of Agric., Oregon State Univ., Corvallis, OR 97331-3002)

Ph.D., Crop Science, 1979, Oregon Stage University, Corvallis, OR. (Major advisor - Prof. Emeritus Arnold Appleby, Dept. of Crop and Soil Sci., Oregon St. Univ., Corvallis, OR 97331-3002)

Employment:

USDA-ARS, weed science, 1974-1979
PPG Industries, Biochemical Field Specialist, 1979-1980
University of Idaho, 1980-present

Teaching:

PlSc 406, How herbicide work Parts I and II (1 credit each, off-campus)
PlSc 410/J510, Biology of Weed (3 credits)
PlSc 438, Pesticides in the Environment (3 credits, team taught)
PlSc 539, Herbicide Fate and Mode of Action (4 credits)
Herbicide Action - an intensive short course taught twice annually at Purdue University, 5 lectures/session

Theses/Dissertations Completed by Graduate Student Advisees and Number of Postdocs Sponsored:
13 M.S. and 14 Ph.D students; 1 Postdoc

Professional Membership:

Weed Science Society of America
Western Society of Weed Science
Idaho Weed Control Association

Honors and Awards:

Young Weed Scientist Award for outstanding young weed scientist in weed sciences, 1990
University of Idaho Annual Award for Research Excellence, 1991
Phi Kappa Phi Distinguished Faculty, University of Idaho, 1992
Fellow, Western Society of Weed Science, 1992
Outstanding Weed Scientist Award, Western Society of Weed Science, 1996
Weed Science Society of American Research Award, 1997

Grants:

Average annual grants for period 1992 though 1997 = $200,000

Selected Publications:

Roche', C.T., D.C. Thill, and B. Shaffi. 1997. Prediction of flowering in common crupina (*Crupina vulgaris*). *Weed Sci.* 45:519-528.

Roche', C.T., D.C. Thill, and B. Shaffi. 1997. Estimation of base and optimum temperatures for seed germination in common crupina (*Crupina vulgaris*). *Weed Sci.* 45:529-533.

Thill, D.C. and C.A. Mallory-Smith. 1997. The nature and consequence of weed spread. *Weed Sci.* 45:337-342.

Young, F.L., A.G. Ogg, Jr., D.C. Thill, D.L. Young, and R.I. Papendick. 1996. Weed management for crop production in the northwest wheat (*Triticum aestivum)* region. *Weed Sci.* 44:429-436.

Stallings, G.P., D.C. Thill, C.A. Mallory -Smith, and L W. Lass. 1995. Plant movement and mediate seed dispersal of Russian thistle (*Salsola iberica*). *Weed Sci.* 43:63-69.

Stallings, G.P., D.C. Thill, C.A. Mallory-Smith, and B. Shafii. 1995. Pollen-mediate gene flow of sulfonylurea-resistant kochia (*Kochia scoparia*). *Weed Sci.* 43:95-102.

Thill, D.C. 1995. Managing the spread of herbicide resistant weeds. In *Herbicide-Resistance Crops: Agricultural, Economic, Environmental, Regulatory, and Technical Aspects*, ed., S.O. Duke, Lewis Publ.-CRC Press, Boca Raton, Florida, pp 331-37.

Holt, J.S and D.C. Thill. 1994. Growth and productivity of resistant plants. In *Resistance to Herbicides in Plants*, eds., S .B. Powles and J.A.M. Holtum, Lewis Publ-CRC Press, Boca Raton, Florida, pp 299-316.

Saari, L.L., J.C. Cotterman, and D.C. Thill. 1994. Resistance to ALS-inhibitor herbicides. In *Resistance to Herbicides in Plants*, eds., S.B. Powles and J.A.M. Holtum, Lewis Publ-CRC Press, Boca Raton, Florida, pp 83-140.

Thill, D.C., J.T. O'Donovan, and C.A. Mallory-Smith. 1994. Integrated weed management strategies for delaying herbicide-resistance in wild oat (*Avena fatua*). *Phytoprotection* 75:61-70.

Thompson, C.R., D.C. Thill, and B. Shafii. 1994. Growth and competitiveness of sulfonylurea-resistant and - susceptible kochia (*Kochia scoparia*). *Weed Sci.* 42:171-79.

Zamora, D.L., and D.C. Thill. 1989. Seed bank longevity of common crupina (*Crupina vulgaris*) in natural population. Weed Technol. 3:166-169.

Thill, D.C., D.L. Zamora, and D.L. Kambitsch. 1986. The germination and viability of excreted common crupina (*Crupina vulgaris*) achenes. Weed Sci. 34:237-240.

Thill, D.C., D.L. Zamora, and D.L. Kambitsch. 1985 The germination and viability of common crupina (*Crupina vulgaris*) achenes buried in the field. Weed Sci. 33:344-348.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
Expires 5/31/98

CURRENT AND PENDING SUPPORT

Instructions:

1. Record information for active and pending projects. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES).
2. All current research to which principal investigator(s)/project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed projects which are being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

NAME (List PI/PD #1 first)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Thill, D.C. & Lass, L.	Current: Lockheed Martin Idaho Tec. Co.	300,000	12/97 to 9/00	5	Protected spatial data exchange from multiple data sources using WWW.
Lass, L. & Thill, D.C.	Center for Pest Mgt, NCSU	17,000	7/1/97 to 6/30/98	2	New remote sensing technology for economical weed control.
Lass, L. & Thill, D.C.	American Farm Bureau	43,000	10/96 to 3/98	2	New remote sensing technology for economical weed control.
Thill, D.C.	CSREES-Jointed goatgrass	7,000	10/97 to 9/98	2	Jointed goatgrass management.
Thill, D.C.	Idaho Wheat Commission	36,000	7/97 to 6/98	10	Weed management in wheat.
Thill, D.C. et al.	NAPIAP	75,639	7/1/97 to 6/30/00	5	Chemical and biological control of picloram-resistant yellow starthistle.
Thill, D.C. et al.	Pending: CSREES	200,000	6/1/98 to 5/31/01		Invasion genetics of *Crupina vulgaris* and *centaurea solstitialis*.

Form CSREES-663 (6/95)

William J. Johnston
Department of Crop and Soil Sciences
Washington State University
Pullman, WA 99164-6420
Phone: (509)335-3620 FAX: (509)335-8674 e-mail: wjohnston@wsu.edu

Education:

B.S. Geology	1965	Pennsylvania State University
M.S. Agronomy	1974	Auburn University
Ph.D. Agronomy	1980	Auburn University

Graduate Faculty Specialization:

Turfgrass Management -- Current emphasis is on snow mold disease evaluation and control, turfgrass germplasm evaluation, and nitrate leaching through sand-based greens.

Grass Seed Production -- Current emphasis is on post-harvest residue management in Kentucky bluegrass seed production, the use of fungicides and surfactants for ergot control in bluegrass seed fields, the evaluation of Kentucky bluegrass germplasm under alternative management regimes, and the characterization of diseases and insects in grass cropping systems.

Professional Organizations and Societies:

Gamma Sigma Delta, Western Society of Crop Science, Sigma Gamma Epsilon, American Society for Horticulture Science, Sigma Xi, American Sod Producer's Association, American Society of Agronomy, International Herbage Seed Production Research Group, Crop Science Society of America, International Turfgrass Society.

Current Pertinent Seed Research Publications:

Johnston, W. J., C. T. Golob, J. W. Sitton, and T. R. Schultz. 1996. Effect of temperature and postharvest field burning of Kentucky bluegrass on germination of sclerotia of *Claviceps purpurea*. Plant Dis. 80:766-768.

Johnston, W. J., C. T. Golob, and J. W. Sitton. 1996. Control of ergot in Kentucky bluegrass fields using Tilt 3.6E and surfactants, 1995. Fungicide and Nematicide Tests 51:372.

Johnston, W. J., and J. W. Sitton. 1996. Disease in dryland and irrigated cropping systems without grass burning. p. 21-24 *In* G. Murray and W. C. Young III (ed.) Grass seed cropping systems for a sustainable agriculture. Special Res. Grant UI, OSU, WSU, and USDA-ARS. Progress Rep. FY95.

Johnston, W. J. 1996. Evaluation of diverse Kentucky bluegrass germplasm for seed production in alternative residue management systems. p. 25-28 *In* G. Murray and W. C. Young III (ed.) Grass seed cropping systems for a sustainable agriculture. Special Res. Grant UI, OSU, WSU, and USDA-ARS. Progress Rep. FY95.

Johnston, W. J. 1996. Turfgrass environmental issues. 1st Golf Theory in Practice Conf. Univ. Ulster-Coleraine, N. Ireland. Abs. p.3.

Johnston, W. J., M. C. Nelson, R. C. Johnson, and C. T. Golob. 1997. Phenotypic evaluation of Kentucky bluegrass: USDA/ARS Plant Introduction germplasm collection. J. Int. Turf. Soc. 8:305-311.

Sitton, J. W., W. J. Johnston, and C. T. Golob. 1997. Control of ergot in Kentucky bluegrass seed fields using Tilt 3.6E and Sylgard 309, 1996. APS Fungicide and Nematicide Tests. 52: 385.

Johnston, W. J., J. W. Sitton, and C. T. Golob. 1998. Control of ergot in Kentucky bluegrass (*Poa pratensis* L.) seed production using adjuvants. J. Appl. Seed Prod. 16: [in press]

UNITED STATES DEPARTMENT OF AGRICULTURE

Cooperative State Research, Education, and Extension Service

Current & Pending Support *for* William J. Johnston

Instructions:

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3. Provide analogous information of all proposed research which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

Name (List #1 PI first)	*Supporting Agency & Agency Number*	*Total $ Amount*	*Effective & Expiration Dates*	*% of Time Committed*	*Title of Project*
	Current				
Johnston, W.J.	NW Turfgrass Assn.	$16,000	1/98 - 99/99	5	*Nitrate leaching at Cocur d'Alene green*
Johnston, W.J.	USDA	$4,300	1/98 - 12/98	2	*Evaluation of NPGS Kentucky bluegrass germplasm for turfgrass*
Johnston, W.J.	USGA	$32,000	1/98 - 12/00	5	*Characterizations of leaching at Cocur d'Alene floating green*
Johnston, W.J.	USDA/ARS	$32,000	7/98 - 6/99	10	*Evaluation of diverse Kentucky bluegrass germplasm for seed production in alternative residue management systems*
Johnston, W.J.	USDA/ARS	$27,500	7/98 - 6/99	10	*Evaluation of diseases and insects in grass seed fields without burning*
	Pending:				
Johnston, W.J.	Washington DOE	$50,000	3/98 - 2/00	5	*Quantifying emissions from cereal residue burning*
Johnston, W.J.	USDA/ARS	$60,000	7/98 - 6/00	5	*Quantifying emissions from Kentucky bluegrass field burning*

Form CSRS-663 (9/92)

VITAE

John E. Hammel

Professor of Soil Physics
Soil Science Division, College of Agriculture
University of Idaho
Moscow, ID 83844-2339
(208)-885-7019; jhammel@.uidaho.edu

Education:

B.S., Physical Science, 1973, Oregon State University
M.S., Soil Science, 1977, Washington State University
Ph.D., Soil Physics, 1979, Washington State University

Professional Experience:

1995-present	Professor, Soil Science Division, University of Idaho
1986-1995	Associate Professor, Soil Science Division., University of Idaho
1982-86	Assistant Professor, Soil Science Division., University of Idaho
1978-82	Assistant Professor, Department. of Agronomy, University of Georgia
1973-1978	Graduate Research Assistant, Department. of Agronomy & Soils, Washington State University

Selected Publications:

Hammel, J. 1989. Long-term tillage and crop rotation effects on bulk density and soil impedance in northern Idaho. Soil Sci. Soc. Am. J. 53:1515-1519.

Hammel, J.E., R.L. Mahler, and P.A. McDaniel. 1993. Impact of nitrogen fertilization of bluegrass on subsurface water quality. p. 33. *In* Agronomy Abstracts. ASA, Madison, WI.

Hammel, J.E. 1994. Effect of high-axle load traffic on subsoil physical properties and crop yields in the Pacific Northwest USA. Soil Tillage Res. 29:195-203.

Salire, E.V., J.E. Hammel, and J.H. Hardcastle. 1994. Compression of intact subsoils under short-duration loading. Soil Tillage Res. 31:235-248.

Hammel, J.E. 1995. Long-term tillage and crop rotation effects on winter wheat production in northern Idaho. Agron. J. 87: 16-22.

McCool, D.K., J.E. Hammel, and R.I. Papendick. 1995. Surface residue management. *In* R.I. Papendick and W.C. Moldenhauer (ed.). Crop residue management to reduce erosion and improve soil quality: Northwest. USDA-ARS. Conservation Research Report No. 40. Washington D.C.

Hammel, J.E. 1996. Water conservation practices for sustainable dryland farming systems in the Pacific Northwest. Amer. J. Alternative Agric. 11:58-63.

Hutchings, J.J., and J.E. Hammel. 1996. Characterization of anion transport beneath a bluegrass field using transfer function models. p. 184. *In* Agronomy Abstracts. ASA, Madison, WI.

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	Current:				
Hammel, Mahler	USDA CSRS (Oregon State Univ.)	$77,177	7/94-6/98	10%	Nitrogen use, cycling, and losses in non-irrigated bluegrass seed production
Hammel	Idaho-Eastern Oregon Onion Commission	$6,200	7/97/6/98	5%	Landfill disposal of cull onions
Hammel	USDA-STEEP	$6,000	7/97-6/00	10%	Impact of long-term no-till on soil physical, chemical, and biological properties
McDaniel, Hammel, King	USGS	$142,200	9/96-8/99	15%	Near-surface hydrology of eastern Palouse region
Hammel w/Guy, Thill, Veseth, Fiez	USDA-STEEPIII	$6,000	7/97-7/00	5%	Residue production and retention in small grain cereal and cool season food legume rotational systems with different tillage practices (UI)
Hammel w/Fiez, Guy, Thill, Veseth	USDA-STEEPIII	$6,650	7/97-7/00	5%	Residue production and retention in small grain cereal and cool season food legume rotational systems with different tillage practices (WSU)
	Pending:				
Brown, Thill, Hammel, Chun	USDA-STEEPIII	$180,000	7/98-6/01	5%	Examine cropping systems including yellow mustard in the Pacific Northwest